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Kamphaus

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(54) **GAS LIFT LATCH**

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E21B 23/03 (2006.01)
E21B 43/12 (2006.01)

(52) **U.S. Cl.**
CPC ***E21B 23/03*** (2013.01); ***E21B 43/122*** (2013.01); ***E21B 43/123*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 43/122; E21B 41/00; E21B 23/03; E21B 32/123; E21B 23/00; E21B 43/123
See application file for complete search history.

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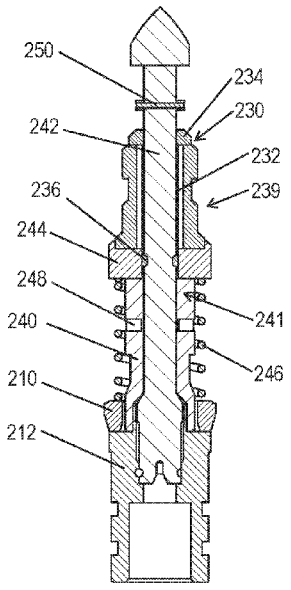
(57) **ABSTRACT**

A latch design for downhole components is provided. The latch design includes a dog assembly instead of a traditional shear pin design to allow the latch to withstand greater forces and more cycles than the traditional design.

13 Claims, 7 Drawing Sheets



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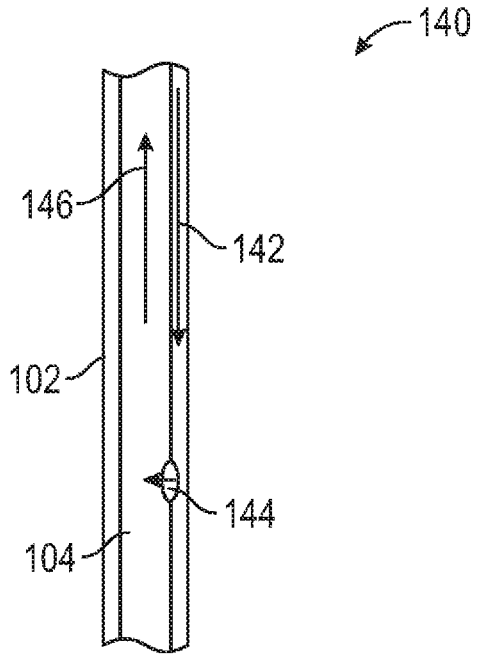

FIG. 1

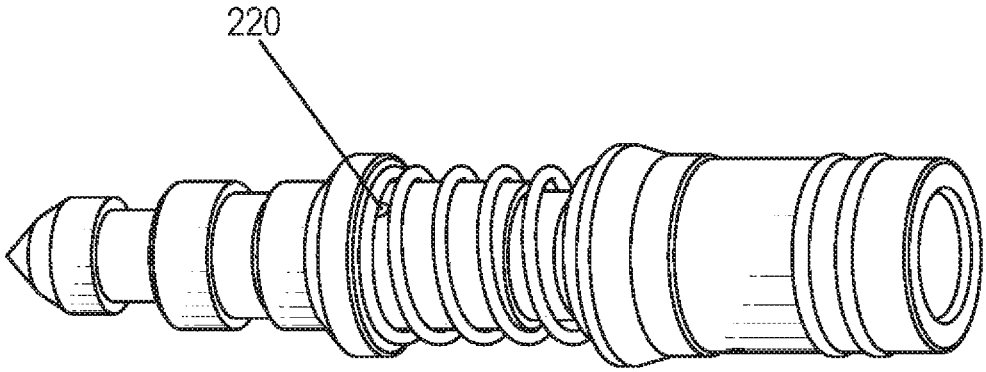

FIG. 2

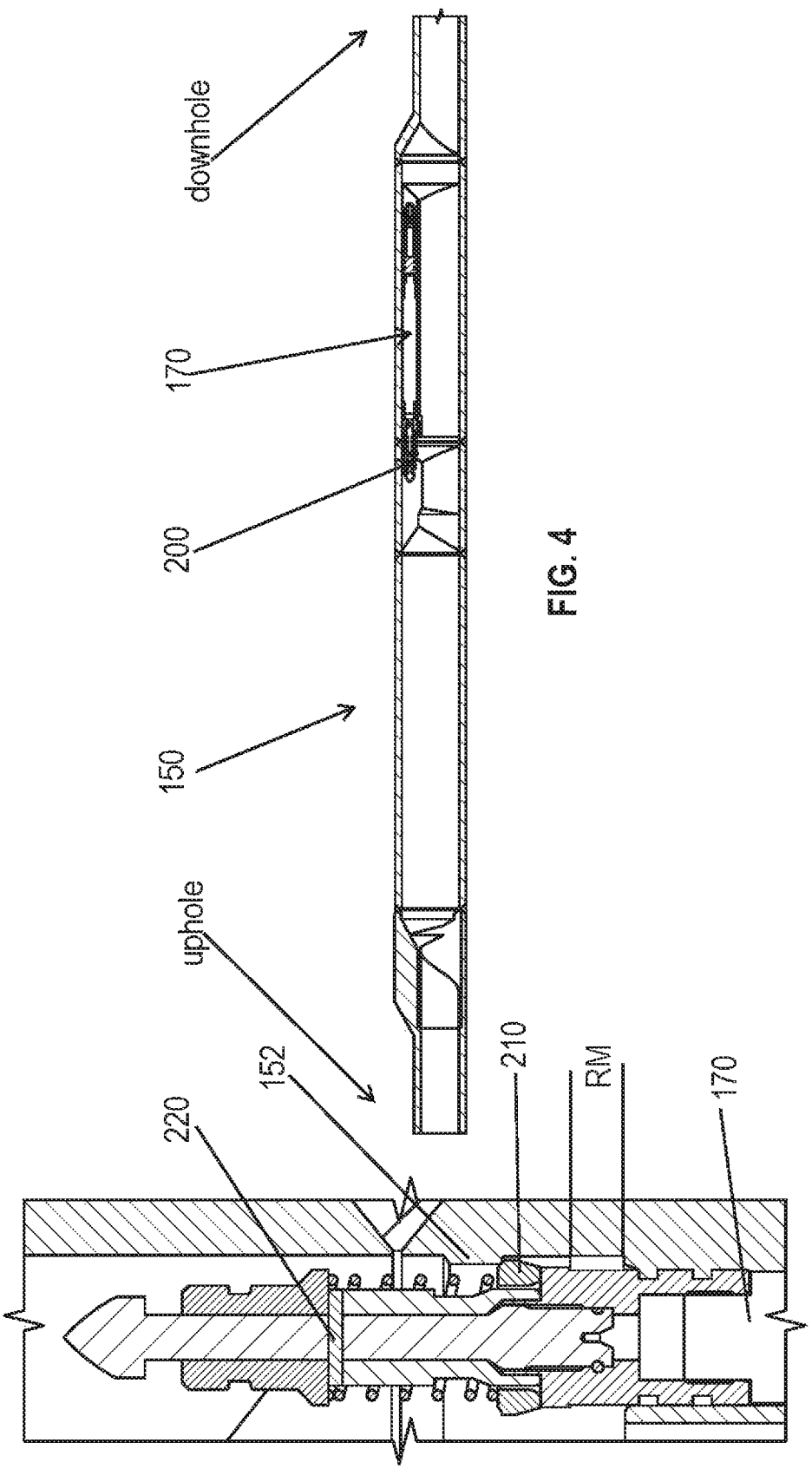

FIG. 4

FIG. 3

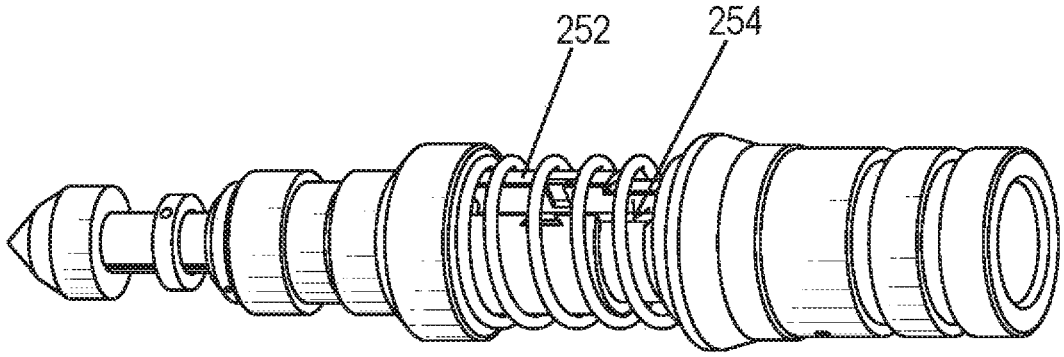

FIG. 5

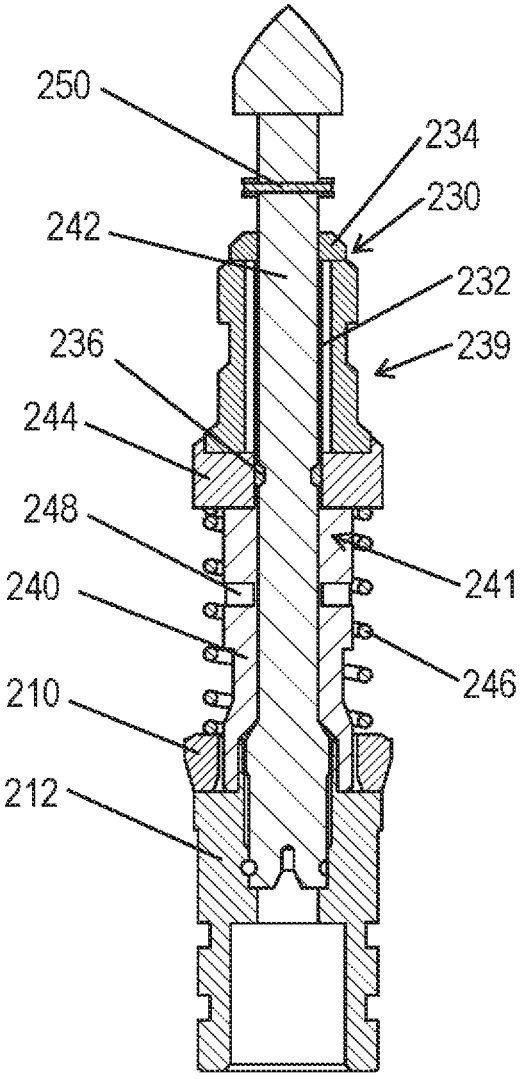

FIG. 6A

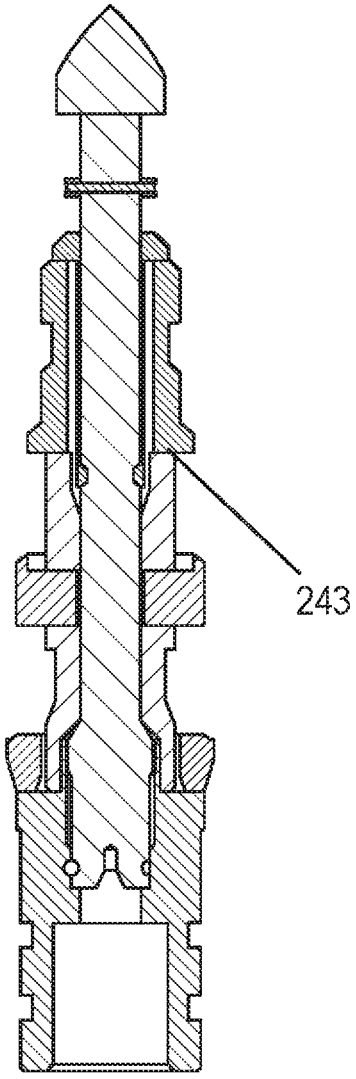

FIG. 6B

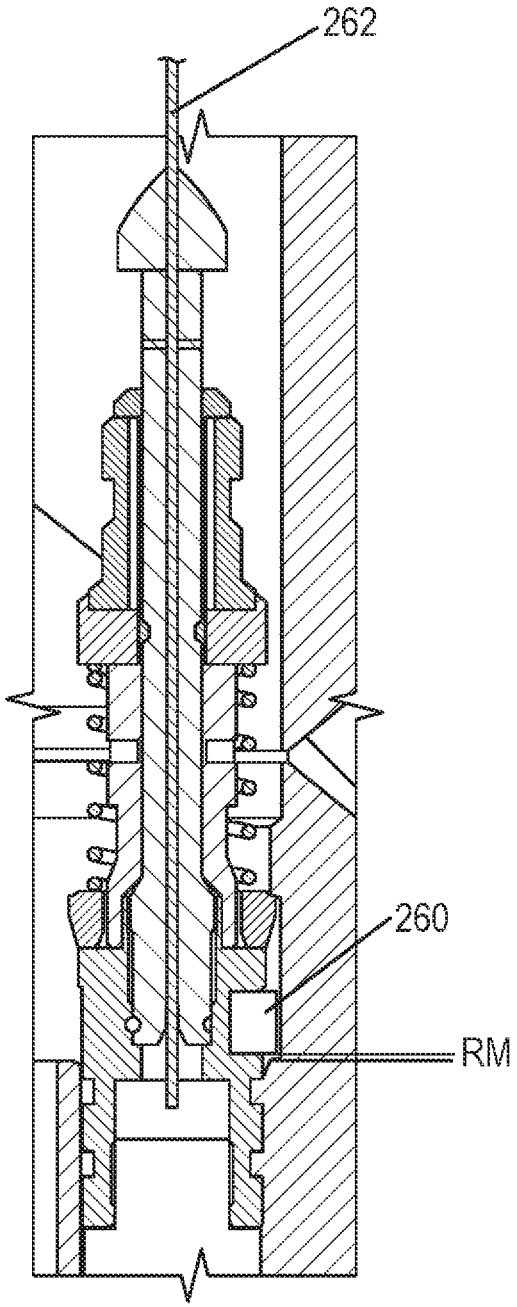

FIG. 7

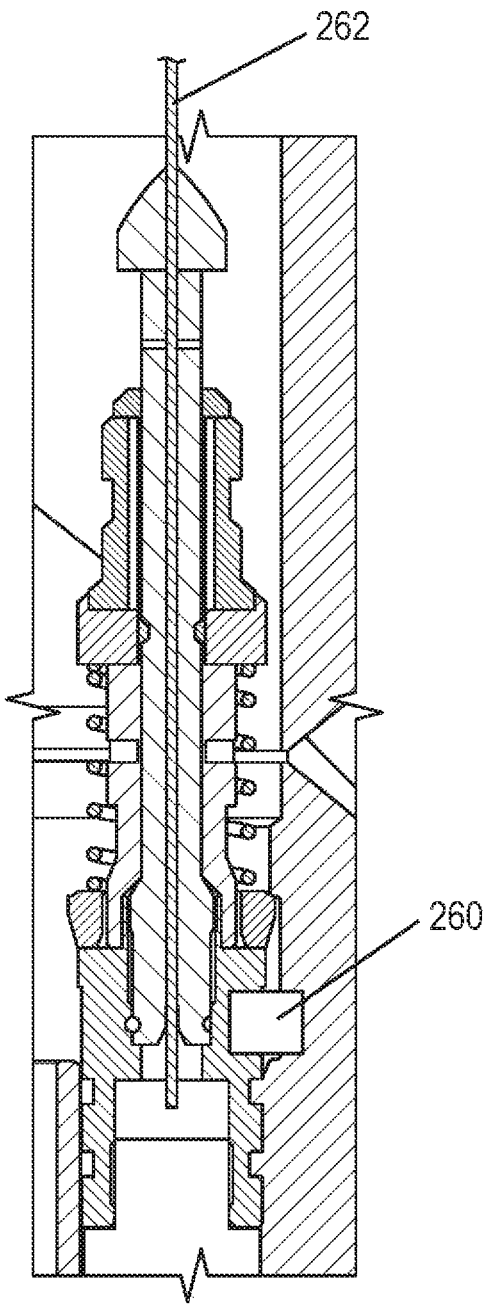

FIG. 8

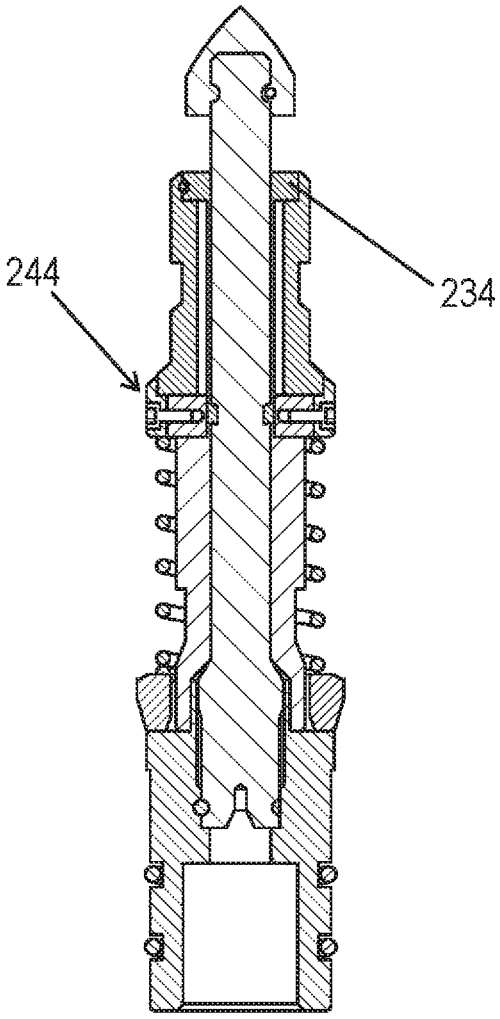

FIG. 9

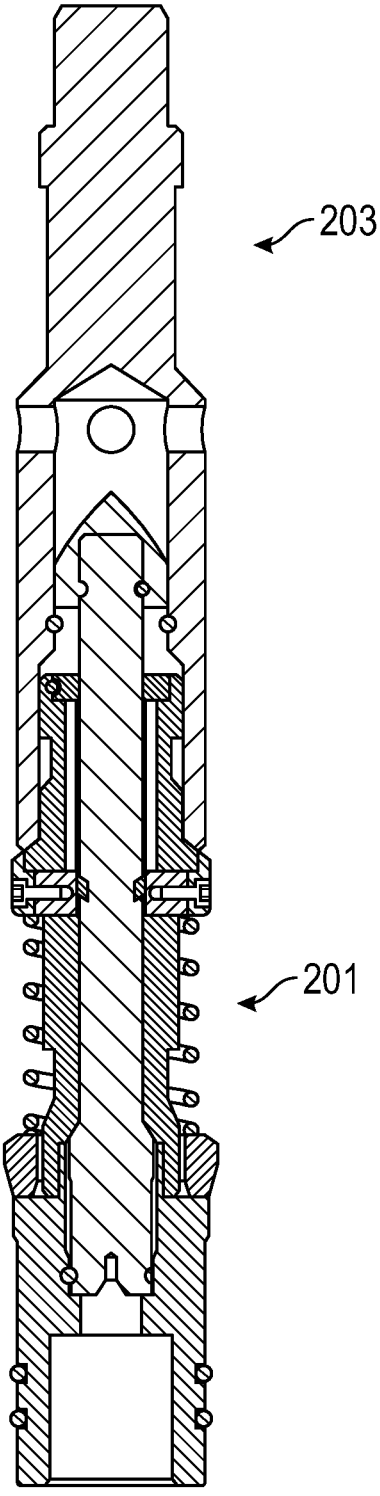

FIG. 10

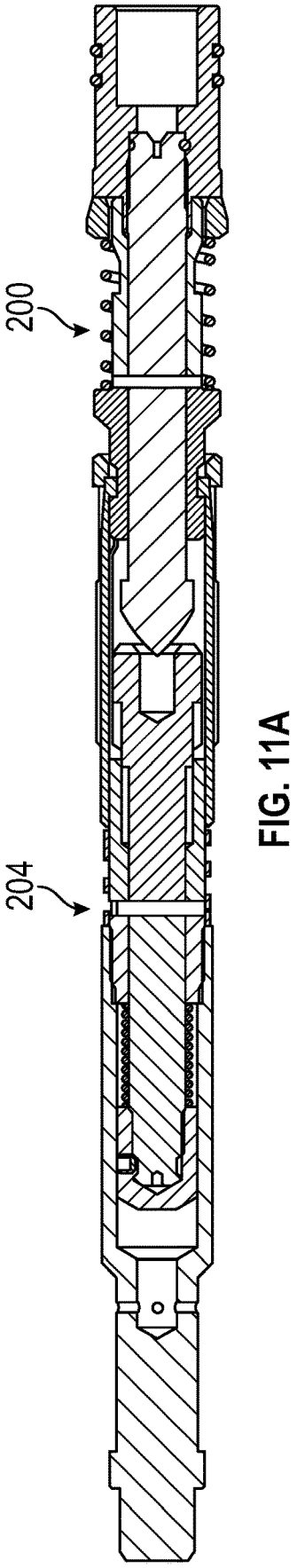

FIG. 11A

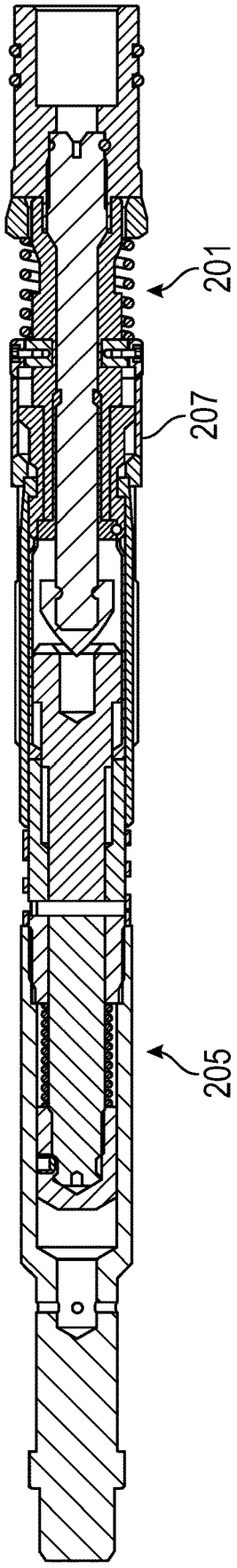

FIG. 11B

GAS LIFT LATCH

CROSS-REFERENCE TO RELATED APPLICATIONS

Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57. The present application is the National Stage Entry of International Application No. PCT/US2021/055377, filed Oct. 18, 2021, which claims priority benefit of U.S. Provisional Application No. 63/092,926, filed Oct. 16, 2020, and U.S. Provisional Application No. 63/093,348, filed Oct. 19, 2020, the entirety of each of which is incorporated by reference herein and should be considered part of this specification.

BACKGROUND

Field

The present disclosure generally relates to gas lift, and more particularly to a latch design for downhole tools.

Description of the Related Art

Oil and gas wells utilize a borehole drilled into the earth and subsequently completed with equipment to facilitate production of desired fluids from a reservoir. Subterranean fluids, such as oil, gas, and water, are produced from the wellbore. In some cases, the fluid is produced to the surface naturally by downhole formation pressures. However, the fluid must often be artificially lifted from wellbores by the introduction of downhole equipment. Various types of artificial lift are available. In a gas lift system, a compressor is located on the surface. The compressor pumps gas down the casing tubing annulus. The gas is then released into the production tubing via gas valves that are strategically placed throughout the production tubing. The gas that is introduced lightens the hydrostatic weight of the fluid in the production tubing, allowing the reservoir pressure to lift the fluid to surface.

SUMMARY

In some configurations, a latch for a downhole component includes a latch stop forming a base of the latch; a running head coupled to and extending upward from the latch stop; a latch body circumferentially disposed about at least a portion of the running head; a latch ring disposed circumferentially about the latch body and positioned adjacent the latch stop; a dog assembly comprising a shaft disposed radially between the running head and the latch body and one or more dogs disposed at a bottom end of the shaft, the dogs configured to engage corresponding features in the running head; and a lock ring disposed circumferentially about the latch body, wherein in a locked position, the lock ring is positioned at an axial position along the latch body such that the lock ring is radially aligned and disposed about the one or more dogs, the lock ring configured to inhibit the one or more dogs from moving radially outward out of engagement with the corresponding features in the running head, and wherein in an unlocked position, the lock ring is positioned along the latch body axially spaced from the one or more dogs, thereby allowing the one or more dogs to move radially outward out of engagement with the running head.

The latch body can include a locking mechanism configured to engage the lock ring in the unlocked position. The latch can include a safety mechanism positioned along the running head above the latch body. The downhole component can be configured to be partially received in the latch stop. The downhole component can be a gas lift valve. The latch can be configured to couple to a running tool for insertion into a wellbore and/or to a pulling tool for retrieval from the wellbore. The latch can include one or more locking dogs coupled to the latch stop. When the latch and downhole component are installed in a downhole mandrel, the locking dogs can be configured to radially expand to a deployed position to limit and axial range of movement of the latch and downhole component in the mandrel. The locking dogs may be configured to engage the mandrel.

In some configurations, a method for retrieving the latch coupled to a downhole component from a mandrel disposed in a wellbore includes running a pulling tool downhole to contact the latch; pushing the lock ring downward along the latch body to the unlocked position using the pulling tool; and allowing the one or more dogs to move radially outward out of engagement with the running head.

The method can include using the pulling tool to pull upward on the latch body, driving the one or more dogs radially outward. The method can include pulling the latch body and dog assembly upward such that the latch body disengages from and clears the latch ring, allowing the latch ring to move radially inward out of engagement with a lug of the mandrel. The method can include removing the latch and downhole component from the mandrel and wellbore.

In some configurations, a latch for a downhole component includes a running head; a latch body circumferentially disposed about at least a portion of the running head; and a collet assembly; wherein in a locked position, the collet assembly engages the running head, and wherein in an unlocked position, the collet assembly is configured to disengage from the running head to allow the latch body and the collet assembly to move axially relative to the running head.

The latch can further include a latch ring. When the latch is in the locked position, the latch ring is disposed circumferentially about the latch body, and when the latch is in the unlocked position, the latch body is configured to displace axially relative to the latch ring and the latch ring is configured to contract radially inward. The latch can include one or more locking dogs. When the latch and downhole component are installed in a downhole mandrel, the locking dogs are configured to radially expand to a deployed position to limit an axial range of movement of the latch and downhole component in the mandrel. In the deployed position, the locking dogs may be configured to engage the mandrel. The downhole component can be a gas lift valve. The latch can be configured to couple to a running tool for insertion into a mandrel in a wellbore and configured to couple to a pulling tool for retrieval from the mandrel.

BRIEF DESCRIPTION OF THE FIGURES

Certain embodiments, features, aspects, and advantages of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein.

FIG. **1** schematically illustrates a portion of an example gas lift system.

FIG. **2** illustrates a perspective view of an example existing latch.

FIG. **3** illustrates a longitudinal cross-section of an assembly including the latch of FIG. **2** and a valve.

FIG. **4** illustrates a longitudinal cross-section of the valve and latch assembly of FIG. **3** disposed in a mandrel.

FIG. **5** illustrates a perspective view of an example latch according to the present disclosure.

FIG. **6**A illustrates a longitudinal cross-section of the latch of FIG. **5** in a locked position.

FIG. **6**B illustrates a longitudinal cross-section of the latch of FIG. **5** in an unlocked position, with a spring element removed for clarity.

FIG. **7** illustrates a longitudinal cross-section of another example latch according to the present disclosure.

FIG. **8** illustrates a longitudinal cross-section of another example latch according to the present disclosure.

FIG. **9** illustrates a longitudinal cross-section of another example latch according to the present disclosure.

FIG. **10** illustrates a longitudinal cross-section of an example latch according to the present disclosure coupled to a running tool.

FIG. **11**A illustrates the latch of FIG. **2** coupled to an existing pulling tool.

FIG. **11**B illustrates an example latch according to the present disclosure coupled to a modified pulling tool.

DETAILED DESCRIPTION

In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of various embodiments. Specific examples of components and arrangements are described below to simplify the disclosure. These are, of course, merely examples and are not intended to be limiting. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments are possible. This description is not to be taken in a limiting sense, but rather made merely for the purpose of describing general principles of the implementations. The scope of the described implementations should be ascertained with reference to the issued claims.

As used herein, the terms "connect", "connection", "connected", "in connection with", and "connecting" are used to mean "in direct connection with" or "in connection with via one or more elements"; and the term "set" is used to mean "one element" or "more than one element". Further, the terms "couple", "coupling", "coupled", "coupled together", and "coupled with" are used to mean "directly coupled together" or "coupled together via one or more elements". As used herein, the terms "up" and "down"; "upper" and "lower"; "top" and "bottom"; and other like terms indicating relative positions to a given point or element are utilized to more clearly describe some elements. Commonly, these terms relate to a reference point at the surface from which drilling operations are initiated as being the top point and the total depth being the lowest point, wherein the well (e.g., wellbore, borehole) is vertical, horizontal or slanted relative to the surface.

FIG. **1** illustrates a downhole portion of an example gas lift system **140**. The gas lift system **140** includes a compressor located at the well surface. In use, the compressor pumps gas down the annulus between the casing **102** and the tubing **104**, as indicated by arrow **142**. The gas is then released into the tubing **104** via one or more gas valves **144** that are strategically placed throughout the tubing **104**. The gas lessens the hydrostatic weight of the fluid in the tubing **104**, allowing the reservoir pressure to lift the fluid to the surface, as indicated by arrow **146**.

The present disclosure provides a latch for downhole tools. Latches according to the present disclosure can be used in gas lift. However, the latches can also be used in various other applications, for example, in any case in which a latch is needed to aid in conveyance, to prevent a tool from dislodging during operations, and/or to aid in retrieval of the tool.

FIGS. **2-4** illustrate a standard latch design. As shown, the latch **200** includes a latch ring **210** and a shear pin **220**. The latch is configured to be coupled to a downhole component, such as a valve **170** as shown in the configuration of FIG. **3**. In use, the assembly of the latch and downhole component, e.g., the valve **170** in the illustrated configuration, can be disposed in a mandrel **150**, for example as shown in FIG. **4**. The latch can move up and down by a distance or range of movement RM shown in FIG. **3**, which is determined by features of the latch and mandrel **150**. The range of movement allows the latch and component (e.g., valve) assembly to accelerate, for example as the assembly is conveyed into the well and the mandrel **150**, until the latch ring **210** impacts a mandrel lug **152**, as shown in FIG. **3**, resulting in dynamic loading of the shear pin **220**.

FIGS. **5-6**B, **7**, and **8** illustrate example latches **201** according to the present disclosure. As shown, latches according to the present disclosure replace the shear pin **220** of the standard latch with a dog or collet assembly **230**. Compared to the shear pin **220**, the dog assembly is more robust and can withstand higher mechanical loads and cyclic loading, which could cause the shear pin **220** to fail. These latches can be installed via the same process and running tool **203** as a standard latch (such as the latch shown in FIGS. **2-4**), for example as shown in FIG. **10**.

An example configuration of a latch according to the present disclosure, shown in FIGS. **6A-6B**, includes an outer latch body **240**, a running head **242**, a latch ring **210**, a latch stop **212**, a lock ring **244**, and a dog assembly **230**. The latch stop **212** can form a base or bottom of the latch. For use, a downhole component, such as a valve **170**, can be partially received in and/or secured to the latch stop **212**. The running head **242** is disposed within (radially within) and extends through (longitudinally or axially through) the latch body **240**. A lower end or portion of the running head **242** can extend into and/or be coupled to the latch stop **212**. A lower end or portion of the latch body **240** can be coupled to and/or disposed adjacent the latch stop **212**. The latch ring **210** is disposed about (radially or circumferentially about) the latch body **240**. The latch ring **210** can be positioned at, adjacent, or proximate a lower or downhole end of the latch body **240**. In the illustrated configuration, the latch ring **210** is disposed adjacent and/or contacts a portion of the latch stop **212**. As shown, the latch body **240** can include an upper portion **239** and a lower portion **241**. The upper **239** and lower **241** portions can be a single monolithic component, or two components coupled (e.g., permanently coupled or integrally formed) together. A lower or downhole facing edge of the upper portion **239** can form a shoulder **243** (shown in FIG. **6**B). A spring **246** is disposed radially or circumferentially about the lower portion **241**.

In some configurations, for example as shown in FIGS. **6A-8**, the latch includes a locking mechanism **248** positioned along an outer surface of the lower portion **241**. Some

configurations lack a locking mechanism **248**, as shown in the configuration of FIG. **9**. In some configurations, as shown in FIGS. **6**A-**6**B the latch includes a safety mechanism **250** positioned along or about the running head **242** above the latch body **240**. The configurations of FIGS. **7**-**9** do not include a safety mechanism **250**.

The dog assembly **230** includes a shaft or body **232** disposed radially between the latch body **240** and the running head **242**. In some configurations, the dog assembly **230** is assembled with the latch body **240**. The latch body **240** and dog assembly **230** can be held together, for example with a pin. An upper or uphole end of the shaft **232** can include or form a flange **234** that has a greater diameter or extends radially outward beyond or to a greater extent than a remainder of the shaft **232**. As shown, the flange **234** can be positioned above and outside of the latch body **240** and can be positioned adjacent or proximate an upper or uphole end of the latch body **240**. In other configurations, for example as shown in FIG. **9**, the flange **234** is disposed radially within the latch body **240**. An upper edge or surface of the flange **234** can be flush with the upper end of the latch body **240** as shown, or may be recessed below the upper end of the latch body **240**. The flange **234** can help secure the dog assembly **230** relative to the latch body **240**. A lower or downhole end of the shaft **232** includes or forms one or more dogs **236** protruding radially inward from and relative to an inner surface of the shaft **232**. The dogs **236** are sized, shaped, positioned, and/or configured to engage the running head **242**, for example, corresponding features in an outer surface of the running head **242**.

The lock ring **244** is disposed about (radially or circumferentially about) the latch body **240**, for example, the lower portion **241** of the latch body **240** in the illustrated configuration. The lock ring **244** can be formed as a single piece or multiple pieces as shown in FIG. **9**. In some configurations, a majority of the lower portion **241** of the latch body **240** can have a reduced diameter compared to the upper portion **239**. The lower portion **241** can include one or more rails **252** (shown in FIG. **5**). In some configurations, the rails **252** project outwardly from and have a greater axial width than the majority of the lower portion **241**. The lock ring **244** can have one or more corresponding channels or features formed in its inner surface and configured to receive and slide along the rail(s) **252**. The dog assembly shaft **232** can be longer than the upper portion **239** such that the dogs **236** extend beyond and are positioned below the upper portion **239**. The lower portion **241** can include one or more longitudinally extending channels **254** circumferentially aligned with or in the area of the dogs **236**. The lock ring **244** can include corresponding projections (or radially thicker portions) extending inwardly from the inner surface of the lock ring **244**, for example, into the channels **254**. The projections prevent or inhibit the dogs **236** from moving or flexing too far radially outward and/or leaving the corresponding features in the running head **242** and/or the channels **254** in the lower portion **241** of the latch body **240**. In some configurations, the lock ring **244** contacts the dogs **236**. The spring **246** can extend between and contact the latch ring **244** and the shoulder **243** of the upper portion **239**.

In use, for example, during installation and/or operation of the valve, movement of the latch and valve assembly is transferred to force on the latch, with the load path through the dog assembly **230** (compared to the shear pin in the design of FIG. **1**). In a locked position, the lock ring **244** is positioned longitudinally aligned with and radially or circumferentially about the dogs **236**, as shown in FIG. **6**A. In the locked position the lock ring **244** keeps the dog(s) **236** engaged with corresponding features in the running head **242**. This arrangement advantageously provides increased robustness and allows the latch to withstand greater forces and more cycles than a traditional shear pin design, as shown in FIG. **1**.

To retrieve a latch and valve assembly according to the present disclosure, a modified pulling tool is used. FIG. **11**A shows a conventional available pulling tool **204** used to retrieve a conventional latch such as latch **200**. FIG. **11**B shows a modified pulling tool **205** design to retrieve a latch according to the present disclosure, such as latch **201**. As shown, the pulling tool **205** includes a distal sleeve **207** coupled to a lower end of the tool **205**. The distal sleeve **207** is configured to contact the lock ring **244** during retrieval.

During retrieval, the pulling tool **205**, e.g., the distal sleeve **207**, pushes the lock ring **244** down, for example past the locking mechanism **248** if present, during a standard "jar down" process. In some configurations, features of the lock ring **244** (for example, on or in the inner surface of the lock ring **244**) engage corresponding features of the locking mechanism **248** to retain the lock ring **244** in an unlocked position, shown in FIG. **6**B (with the spring **246** removed for clarity). With the lock ring **244** in the unlocked position, the collet is unsupported and the dogs **236** are able to move radially outward and disengage from the running head **242**. The pulling tool **205** pulls upward on the latch body **240**, driving the dogs **236** outward and allowing the latch body **240** and dog assembly **230** to move upward together, for example, relative to the running head **242**. When the latch body **240** is supporting the latch ring **210**, the valve and latch assembly is kept latched into the mandrel **150**. When the latch body **240** moves upward enough to disengage from and clear (rise above) the latch ring **210**, the unsupported latch ring **210** can move or contract toward the inner diameter of the latch and away from the mandrel lug **152**, thereby releasing the valve and latch assembly from the mandrel **150**.

In some configurations including the safety mechanism **250**, with the lock ring **244** in an unlocked position, the latch body **240** and dog assembly **230** move upward until they shoulder against the safety mechanism **250**. Further pulling with the pulling tool **205** shears a shear pin in the safety mechanism **250**, allowing the latch body **240** to move far enough upward to fully disengage from the latch ring **210** and release the valve and latch assembly.

FIG. **7** illustrates another configuration of a latch according to the present disclosure that can share or include some or all of the features shown in and described with respect to FIGS. **5**-**6**B. The configuration of FIG. **7** includes one or more locking dogs **260** disposed in or on or coupled to the latch stop **212**, and an operating rod **262** extending longitudinally through the running head **242** and extending out of the top of the latch. During installation of the latch and downhole component (e.g., valve), the locking dogs **260** are held internally in the latch stop **212** or held in a retracted position. Once the latch and valve assembly is installed and held in place in the mandrel **150** by the latch ring **210** engaging or contacting the mandrel lug **152**, the installation tool pulls on the operating rod **262**. Pulling the operating rod **262** releases the locking dogs **260** into an expanded or deployed position in which the locking dogs **260** extend into an annular space between the mandrel **150** and the latch **201**. The locking dogs **260** help significantly reduce the range of movement RM allowed, for example during dynamic pressure changes. This reduction in the range of movement reduces impact loads on the latch.

FIG. **8** illustrates another configuration of a latch according to the present disclosure that can share or include some or all of the features shown in and described with respect to FIGS. **5-6**B. The configuration of FIG. **8** includes one or more locking dogs **260** similar to the configuration of FIG. **7**. However, in the configuration of FIG. **8**, when in the expanded or deployed position, the locking dogs **260** engage the mandrel **150** to secure or lock the latch to or relative to the mandrel **150**. Various mechanisms can be used to deploy the locking dogs **260** and/or secure the locking dogs **260** to the mandrel **150**, for example, teeth on the locking dogs **260**, energized elastomeric components, energized polymer components, and/or chemical reaction(s) to create an expanding material.

Language of degree used herein, such as the terms "approximately," "about," "generally," and "substantially" as used herein represent a value, amount, or characteristic close to the stated value, amount, or characteristic that still performs a desired function or achieves a desired result. For example, the terms "approximately," "about," "generally," and "substantially" may refer to an amount that is within less than 10% of, within less than 5% of, within less than 1% of, within less than 0.1% of, and/or within less than 0.01% of the stated amount. As another example, in certain embodiments, the terms "generally parallel" and "substantially parallel" or "generally perpendicular" and "substantially perpendicular" refer to a value, amount, or characteristic that departs from exactly parallel or perpendicular, respectively, by less than or equal to 15 degrees, 10 degrees, 5 degrees, 3 degrees, 1 degree, or 0.1 degree.

Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims. It is also contemplated that various combinations or sub-combinations of the specific features and aspects of the embodiments described may be made and still fall within the scope of the disclosure. It should be understood that various features and aspects of the disclosed embodiments can be combined with, or substituted for, one another in order to form varying modes of the embodiments of the disclosure. Thus, it is intended that the scope of the disclosure herein should not be limited by the particular embodiments described above.

What is claimed is:

1. A latch for a downhole component, the latch comprising:

a latch stop forming a base of the latch;

a running head coupled to and extending upward from the latch stop;

a latch body circumferentially disposed about at least a portion of the running head;

a latch ring disposed circumferentially about the latch body and positioned adjacent the latch stop;

a dog assembly comprising a shaft disposed radially between the running head and the latch body and one or more dogs disposed at a bottom end of the shaft, the dogs configured to engage corresponding features in the running head; and

a lock ring disposed circumferentially about the latch body,

wherein in a locked position, the lock ring is positioned at an axial position along the latch body such that the lock ring is radially aligned and disposed about the one or more dogs, the lock ring configured to inhibit the one or more dogs from moving radially outward out of engagement with the corresponding features in the running head, and

wherein in an unlocked position, the lock ring is positioned along the latch body axially spaced from the one or more dogs, thereby allowing the one or more dogs to move radially outward out of engagement with the running head.

2. The latch of claim **1**, the latch body comprising a locking mechanism configured to engage the lock ring in the unlocked position.

3. The latch of claim **1**, further comprising a safety mechanism positioned along the running head above the latch body.

4. The latch of claim **1**, wherein the downhole component is configured to be partially received in the latch stop.

5. The latch of claim **1**, wherein the latch is configured to couple to a running tool for insertion into a wellbore.

6. The latch of claim **1**, wherein the downhole component is a gas lift valve.

7. The latch of claim **1**, further comprising one or more locking dogs coupled to the latch stop.

8. The latch of claim **7**, wherein when the latch and downhole component are installed in a downhole mandrel, the locking dogs are configured to radially expand to a deployed position to limit an axial range of movement of the latch and downhole component in the mandrel.

9. The latch of claim **8**, wherein in the deployed position, the locking dogs are configured to engage the mandrel.

10. A method for retrieving the latch of claim **1** coupled to a downhole component from a mandrel disposed in a wellbore, the method comprising:

running a pulling tool downhole to contact the latch;

pushing the lock ring downward along the latch body to the unlocked position using the pulling tool; and

allowing the one or more dogs to move radially outward out of engagement with the running head.

11. The method of claim **10**, further comprising using the pulling tool to pull upward on the latch body, driving the one or more dogs radially outward.

12. The method of claim **11**, further comprising pulling the latch body and dog assembly upward such that the latch body disengages from and clears the latch ring, allowing the latch ring to move radially inward out of engagement with a lug of the mandrel.

13. The method of claim **12**, further comprising removing the latch and downhole component from the mandrel and wellbore.

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